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Estimating the individual risk of diabetes: not based solely on overweight

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ABSTRACT

- Overweight (BMI ≥ 25 kg/m²) and, in particular, high abdominal fat levels (waist circumference ≥ 88 cm in women and ≥ 102 cm in men), are among the main risk factors for the development of type 2 diabetes mellitus.
- Results from the Hoorn Study show that 16.3% of overweight participants with high abdominal fat levels developed diabetes within 6 years, compared with 6.8% of those who were not overweight and had low abdominal fat levels.
- Information on overweight and abdominal fat level solely is not enough to properly estimate the risk of type 2 diabetes in an individual patient.
- A combination of information about overweight and information about the major risk factors for diabetes, such as family history of diabetes, age, blood pressure and elevated blood glucose levels, in the form of a calculated diabetes risk score, can provide a more accurate estimate of the individual risk of developing diabetes.

Due to an unhealthy lifestyle, inappropriate diet and poor physical condition, obesity is becoming a major health problem. Obesity is a risk factor for type 2 diabetes. In this article, the prevalence of obesity, the relationship between obesity and diabetes, and the possibility to estimate the individual risk of developing diabetes, based on obesity and other risk factors, are discussed.

The prevalence of obesity

In 2005/2006, respectively 30% and 45% of females and males in the Netherlands between 18 and 70 years of age were overweight, defined as a Body Mass Index (BMI) between 25 and 30 kg/m². In addition, 12% of both males and females had a BMI of 30 kg/m² or higher, which is defined as obesity (1). Moreover, 28% of the males and 43% of the females had abdominal obesity (1) (a waist circumference of 88 cm or more in females and 102 cm or more in males (2)). Compared to other Western countries, the prevalence of obesity is relatively low in the Netherlands. In all European countries, overweight is more pronounced among men, while more females than males are obese (1).

The association between obesity and type 2 diabetes

The association between obesity and type 2 diabetes has been widely studied. A large study in Finland showed that, compared to a BMI of less than 25 kg/m², a BMI over 30 kg/m² indicated a 3-fold increase in the risk of developing diabetes. Moreover, participants with a large waist circumference (88 cm or more in females and 102 cm or more in males) had a 4-fold increase in the risk of developing diabetes, compared to participants with a normal waist circumference (3). Among 43.000 women in the USA, the risk of developing diabetes in females with a waist circumference of 92 cm was 5 times higher than in females with a waist circumference of 67 cm, adjusted for BMI and other risk factors for diabetes (4).

In the Netherlands, the number of studies that have focused on obesity and diabetes is limited. One study is the Hoorn Study, a cohort study of glucose intolerance among 2,484 randomly selected inhabitants of the town of Hoorn, between 50 and 75 years of age. At baseline in 1989, a physical examination and a 75 g oral glucose tolerance test (OGTT) were performed. During the following years, several re-examinations were performed. After an average follow-up of 6 years, 10% of the participants had developed diabetes (5). Waist circumference was found to be a better predictor for the development of diabetes than BMI (6).

The results of above mentioned studies demonstrate the relationship between (abdominal) obesity and diabetes at population level. However, in clinical practice, the main question is: what is the risk that a patient with (abdominal) obesity will develop diabetes? In order to answer this question, we performed additional analyses on the data from the Hoorn Study. Of the 1,351 participants with no diabetes at baseline, 858 (63,5%) were overweight (BMI ≥ 25). Of these, 11.7% had developed diabetes after 6 years, compared to 6.9% of the 493 participants who were not overweight at baseline.

Comparable results were found for a large waist circumference. Of the 970 participants with a normal waist circumference at baseline, 7.5% had developed diabetes after 6 years, compared to 15.9% of the 383 participants with a large waist circumference at baseline. Figure 1 shows the incident cases of diabetes, stratified for BMI and waist circumference. This figure shows that the risk of diabetes is the highest in participants with both overweight (BMI) and abdominal obesity (waist circumference).

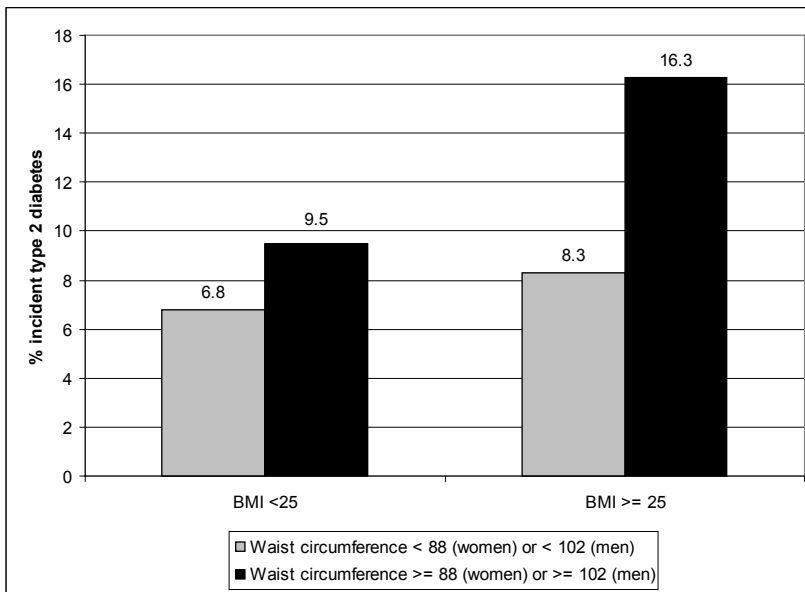


Figure 1.

The incidence of diabetes after 6 years of follow-up, stratified according to BMI and waist circumference at baseline

Obesity as predictor of developing diabetes

Limitations of obesity as a predictor

Overweight and obesity do not entirely explain the individual risk of developing diabetes. As outlined above, 11 out of 100 participants in the Hoorn Study who were overweight had developed diabetes after 6 years. The individual risk of diabetes can be estimated more accurately by a combination of risk factors for diabetes.

The most important predictor of diabetes is a slightly elevated glucose level, both fasting (6.1-7.0 mmol/l) and postload (2 hours after a 75-gram OGTT: 7.8-11.1 mmol/l). In the Hoorn Study, 64.5% of the participants with elevated fasting and postload glucose levels had developed diabetes after 6 years (5). Other risk factors are low HDL cholesterol, high triglyceride levels and hypertension (7). Age is also an important predictor: every year there is a 4%

increase in the risk of developing diabetes (8;9). Moreover, a family history of diabetes results in a 2-fold increase in the risk of developing diabetes, compared to no family history of diabetes (8;9). Ethnicity also plays a role: the prevalence of diabetes in people from Hindi, Moroccan, Turkish or Surinamese ancestry is 3 to 6 times higher than in people with a Caucasian background (10). Moreover, Asian people with a normal BMI ($<25 \text{ kg/m}^2$) more often develop diabetes compared to Caucasian people with a normal BMI (11;12). A possible explanation is that Asian people have a higher percentage of abdominal body fat, compared to Caucasian people with the same BMI.

Combining risk factors to predict type 2 diabetes

Risk factors can be used to estimate the individual risk of developing diabetes based on a combination of several risk factors. A frequently used risk score which predicts the risk of developing diabetes within 5 years is the Finnish FINDRISK (Table 1) (3). This risk score is used on the Dutch website www.kijkopdiabetes.nl. Alsema et al. validated the FINDRISK in 3 cohort studies in the Netherlands, including the Hoorn Study (13).

The following example illustrates how a combination of risk factors provides a more accurate prediction of the risk of diabetes than overweight alone. Imagine a 40-year old man with a BMI of 31, a waist circumference of 104 cm and normal blood pressure. He has no family members with diabetes and was never found to have elevated glucose levels. Based on these data, the FINDRISK estimates that he has a 10% risk of developing diabetes within the next 5 years. Next, we imagine a 65-year old man with the same BMI and waist circumference. In contrast, this man has a high blood pressure and slightly elevated glucose levels, and his father had diabetes. As a result, he has a 20% risk of developing diabetes within 5 years. The difference in the estimated risks for these two men illustrates that overweight alone is a limited predictor of diabetes and that other risk factors provide important additional information.

Table 1. Finnish Diabetes Risk Score. The total score is translated into an estimated chance of developing diabetes within 5 years.

ITEM	Points	ITEM	Points
Age (years)		Use of blood pressure medication	
< 45	0	No	0
45-54	2	Yes	2
55-64	3		
> 64	4		
BMI (kg/m ²)		History of high blood glucose	
< 25	0	No	0
25-30	1	Yes	5
>30	3		
Waist circumference (cm)		Family history of diabetes (type 1 or 2)	
Men	Women	No	0
<94	<80	Yes, father/mother/brother/sister/child	5
94-102	80-88		
>102	> 88		
TOTAL SCORE:			
< 7: Estimated risk of 2 out of 100			
7-9: Estimated risk of 10 out of 100			
> 10: Estimated risk of 20 out of 100			

Why estimate the risk of developing type 2 diabetes?

A diabetes risk score provides information about the individual risk of developing diabetes. In a large study in the USA it was found that adding blood glucose levels and blood lipid levels to the risk score did not substantially improve the prediction of diabetes (14). The simplicity of the risk score makes it useful for individuals with an interest in their own personal risk, and also for health care providers who want to estimate the risk for their patients.

Tracing and counseling individuals with a high risk of developing diabetes can reduce the prevalence of diabetes and diabetes-related complications in the future. Large-scale intervention studies have shown that a healthy lifestyle can reduce the risk of developing diabetes by 58% in individuals with impaired glucose tolerance and obesity (15;16). Moreover, it has been shown that individuals have already developed micro- and macrovascular

complications by the time they are diagnosed with diabetes (17;18). Some patients with an early diagnosed, due to screening, already have diabetes-related complications (19).

Conclusion

Obesity, especially abdominal obesity, is a strong risk factor for the development of diabetes. Data from the Hoorn Study showed that 16.3% of the participants with general obesity and abdominal obesity developed diabetes within 6 years. This implies that the predictive value of obesity to estimate the individual risk of developing diabetes is limited. The inclusion of other important risk factors for diabetes, such as family history of diabetes, age, blood pressure and elevated glucose levels, will provide a more accurate estimate of the individual risk. A diabetes risk score, including different risk factors for diabetes, is therefore helpful to estimate the individual risk of developing diabetes.

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